ATTORNEY DOCKET NO.: CIS01-23(4696)

### IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:

Suchitra Raman

Serial No.:

10/044,212

For:

METHODS AND APPARATUS FOR POOLING AND DEPOOLING

THE TRANSMISSION OF STREAM DATA

Filing Date:

November 20, 2001

Examiner:

Gillis, Brian J.

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### Certificate of Mailing Under 37 C.F.R. §1.8

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### MAIL STOP AMENDMENT

Commissioner for Patents PO Box 1450 Alexandria, Virginia 22313-1450

### **AFFIDAVIT UNDER 37 CFR 1.131**

1. I, Suchitra Raman, am an inventor of "Methods and Apparatus for Pooling and Depooling the Transmission of Stream Data" now before the U. S. Patent Office as Application Number 10/044,212.

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- 2. It is my belief that inventorship in the above-identified patent application is correct.
- 3. Prior to August 27, 2001, I conceived of the invention of "Methods and Apparatus for Pooling and Depooling the Transmission of Stream Data" now before the U. S. Patent Office as Application Number 10/044,212.
- 4. Prior to August 27, 2001, I reduced to practice the invention described and claimed in Application Number 10/044,212, now pending in the U.S. Patent Office, as evidenced by the attached document entitled "Patent and Details (#131488), Packet Pooling for Efficient Stream Distribution over Packet-switched Networks".
- 5. All of the statements made herein are of my own knowledge and are true, these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment or both, under § 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application and any patent issuing thereon, or any patent to which this verified statement is applied.

5 6 05
Date of Signature

Suchitra Raman

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II FEEDBACK II DIRECTORY:

Patent Idea Details (#131488) Cisco Patents On-Line (CPOL) Main menu | Reports | Find | Contact | Help

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#131488: Packet Pooling for Efficient Stream Distribution over Packet-switched

Networks

Status Info

Entered: 08-May-2001

Modified: 08-May-2001

State: Approved. In Process.

Current Inventors:

Suchitra Raman (suraman).

History:

No additional history currently available.

File Date: ---Serial #: ---

Issue Date: ---U.S. Pat #: ---

View patent: Not available.

**Full Details** 

(As submitted)

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Division:

WALTHAM Info: SP PCIPS

media can be distributed using RTP or other equivalent protocol (e.g., RealNetworks' RDT protocol, Microsoft's MMSU/MMST protocols). This invention describes how to efficiently packetize RTP stream data in a Background: Content distribution networks (CDNs) use application-layer multicast to efficiently distribute live and stored content to edge nodes.

method suitable for efficient transport through such an application-layer multicast network.

communication method. One-to-many distribution at layer 3 of the traditional protocol stack can be accomplished using IP multicast Live stream distribution calls for an efficient one-to-many

ubiquitously support this extension to the IP service model. This has Packet replication is also referred to as stream splitting when used placed at selective network locations perform packet replication to provide efficient one-to-many transport through the network. (Note: given rise to the "overlay" model in which intermediate appliances couting. However, today's IP routing infrastructure does not in stream distribution.)

appliance nodes that leads to efficient stream transport through the clients that requested it. The application-layer multicast topology appliances, and so on, until the stream ultimately reaches all its An application-layer multicast network consists of appliance nodes forms an overlay routing layer on top of the existing unicast IP routing layer. Here, we describe packetization technique at the responsible for splitting input streams to multiple downstream overlay network.

known average (encoded) bitrate. Many CDN workloads consist of large numbers of "thin" (low bitrate) streams such as 64 kbps audio sourced A stream splitting appliance has many input streams each at a certain size depends on the specific encoding algorithm. However, in general, low fidelity streams consist of small datagrams (100-300 byte The exact relationship between encoding bitrate and average packet by online radio stations, audiocast, narrowband video (<300 Kbps). packets).

This common workload that comprises many small packets has two problems:

- interrupt handling and header processing on a per-packet basis. (i) Forwarding many low bitrate (thin) streams each with small datagrams puts a heavy load on each forwarding appliance
- Most L2 and L3 devices do not handle a large number of small datagrams forwarding devices such a routers and L2 switches in the network path. optimally because of increaased packet processing and route lookup (ii) Such a workload also has consequences on the lower layer overhead

packets, from independent streams, that are destined along the same path into the same IP datagram. We call such an aggregate datagram a Summary: The main idea in stream pooling is to aggregate or pool multiple RTP "packet pool". Both the interrupt handling overhead and header processing can be optimized by this aggregation method. This me requires the following issues to be addressed: What criteria to use to pool packets from potentially independent flows into the same packet pool? (1)

- (2) How should an intermediate node that is presented with a packet pool forward the pool datagram?
- How should a node separate or reconstruct individual packets from a packet pool? We call this "de-pooling." (3)

We outline how our stream pooling technique handles these issues.

(1) Packet Pool Construction:

How does an appliance detect packets that would benefit from being transported in a single IP datagram?

together to the next stream forwarding node. In other words, the stream aggregation step uses a lookahead of one to determine how much A simple implementation would apply stream pooling arbitrarily to stream packets of any flow as long as they are known to travel sharing of stream paths occurs between the diferent flows. (a) Which packets should be pooled?

generalized lookahead algorithm is described below. This requires looking up the entire forward path of a given stream by inspecting the routing tables. The details of this lookup depend on the exact routing use a link-state multicast routing protocol, such as M-OSPF, based on stream IDs. In this case, the entire path of appliance nodes taken by each stream appliance. We assume that the entire appliance network is a stream is available from the OSPF link state database available at flows is known, a more elaborate aggregation scheme is possible. The protocol being used. This lookup is simplest when the overlay nodes If more information about the overlay path taken by the different using a single OSPF area. Aggregation is based on the amount of correlation between descendant sets.

- More packets an appliance can aggregate, the greater the performance advantages. However, a wait time may be required to gather enough appliance impose on a packet while making pooling decisions. (b) What are the timing constraints of the pooling process? packets, Hence, what is the maximum per-hop delay that an Multiple criteria are possible here.
- (a) Target candidate size: In the first scheme, each stream forwarding aggregates and forwards them along. Pooling is performed only with appliance reads a constant number of packets, constructs a stream

number of thin streams in its input queue. Except for the additional transmission unit). This works well when the appliance has a large processing on the aggregator (and de-aggregator) node, this method does not impose any additional delays on stream packets. those stream packets that are much smaller than an MTU (maximum

delay: This variant is better suited when the bandwidth is not high enough and the aggregation method can incur an additional delay.

Wait time = MIN(T\_p, T\_d);

 $T_D = Time$  to get p packets  $T_A = Max$ . delay.

(2) Forwarding a packet pool:

extraneous RTP packets within the packet pool to downstream nodes is forwarding. However, if the overhead of unnecessary transmissions of A node that is replicating/forwarding packets to downstream nodes not strictly required to inspect the packet pool prior to unacceptable, a node may de-pool the packet.

(3) De-pooling:

appliance is a leaf node in the overlay distribution network, it needs to inspect the packet pool and separate them into individial packets This is required only at the edges of the network. I.e., if an before delivering to a client.

header. The packet pool header is an index that provides information However, if de-pooling is necessary within the distribution network, it is done based on the packet pool header in the extended RTP on each of the contained packets.

Advantages: Current stream splitting products do not take advantage of shared paths to aggregate packets. As a result, their per-appliance stream capacity is small. With stream pooling, each appliance can deliver greater stream throughput.

recently proposed Stream Engine product can use stream pooling for efficient distribution. Small packets can otherwise adversely impact the stream processing performance of each Stream Engine. Cisco use: Cisco's CDN products can benefit from this technique. The

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infringement. RealServer splitters are in a position to use it for efficient stream distribution, but do not currently detecting However, any product that advertises high stream splitting by other or stream forwarding capability must be examined for Method of There is no externally visible effect of this technique. do so in their RealSystem iQ network. use by other companies:

Previous None.

public use:

First written 08-May-2001

record date:

First written ---

URLs: record

Supporting docs URLs:

Notes:

### Review Information

Progress:	Review Group	Reviewer Users	Status	
	SPLOB-PCIPS-CST	SPLOB-PCIPS-CST mcieslak, otoole*, mair Reviewed	Reviewed	

\*Designated Reviewer.

This idea has been approved. Please see the Status Info above for its current status.

Date: 5/31/2001 21:16

Comments:

User ID: otoole

REASON FOR APPROVAL:

Now I understand this one and why it isn't the same as MPLS labels.

OTHER NON-CISCO USERS OF THIS INVENTION: Inktomi/FastForward, ExtremeNetworks, Alteon Tage o of o

## Probably documented, but even if not, would be obvious to sniffer. DETECTION OF NON-CISCO USE:

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